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THE GEOMORPHOLOGY OF THE SWAN HILLS AREA, ALBERTA

DENIS A. ST-ONGE

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CONTENTS

Illustrations

ABSTRACT

A detailed geomorphological map (Map 1206A, Geological Survey of Canada) illustrates the complexity of landforms on a portion of the south slopes of the Swan Hills in central Alberta. The major landforms such as the Swan Hills, the "Virginia Hills", and the Freeman River valley are inherited from a preglacial landscape. They consist of a series of gravel-covered benches leading down from the Swan Hills plateau to the alluvial plain of an ancestral Athabasca River valley. Glaciers did little to modify this landscape but meltwater streams carved numerous channels which are now generally covered by extensive bog deposits.

RÉSUMÉ

Une carte géomorphologique détaillée (carte 1206A, Commission géologique du Canada) illustre la complexité du modelé d'une partie des versants sud des collines Swan au centre de l'Alberta. Les grandes unités du relief de cette région représentées par les collines Swan, les collines Virginia et la vallée de la rivière Freeman sont des vestiges d'un paysage pré-glaciaire. Ces collines sont découpées en une série de gradins recouverts de graviers dont les altitudes respectives vont en s'abaissant à partir du plateau sommital des collines Swan jusqu'au niveau de la plaine alluviale de la vallée pré-glaciaire de la rivière Athabasca. Le passage des glaciers n'a guère modifié ce paysage, mais les eaux courantes de la fonte des glaces ont creusé de nombreux chenaux pro-glaciaires dont la majorité sont maintenant comblés de dépôts organiques tourbeux.

THE GEOMORPHOLOGY OF THE SWAN HILLS AREA, ALBERTA 83 J/11 W

INTRODUCTION

The Swan Hills, an area of very rugged terrain in the densely wooded central part of Alberta, are limited to the north by Lesser Slave Lake, to the east and south by the Athabasca River, and to the west by rolling lowlands drained by the Iosegun and Goose rivers. They are a maturely dissected plateau rising to a maximum altitude of 4,475 feet a.s.l. or nearly 2,600 feet above Lesser Slave Lake. They form a watershed for numerous streams draining north into Lesser Slave Lake, east and south into the Athabasca River, and west into the Little Smoky River system.

The deep valleys carved by the Swan and Driftpile rivers and their tributaries have reduced the plateau to a series of elongated spur ridges extending radially northeastward from a high hill in N.E. ¼ tp. 66, rge. 13, W5th meridian. A gentle slope, scoured by several meltwater channels, links the tops of the hills to a rolling bench to the east, which is between 2,500 to 3,000 feet high. A similar surface joins the summit of the hills to the Freeman River valley to the south. Between the Freeman River and the Athabasca River a hilly region, dissected by numerous broad valleys, rises to nearly 4,200 feet a.s.l. It is known locally as the "Virginia Hills".

Location

Swan Hills map-area comprises 175 square miles (460 square kilometres) within the drainage basin of the Freeman River. It is located between longitude 115°15' and 115°30' west and latitude 54°30' and 54°45' north. This area forms part of the Alberta Plateau division of the Interior Plains Region (Bostock, 1970).

Climate

Table I summarizes climatic data for the Whitecourt Station, location 54°08'N, 115°41'W, 2,280 feet a.s.l. altitude. It indicates that this area has cold, dry winters and cool to warm, wet summers.

Table I gives climatic data for Swan Dive Forestry Station for the years 1964, 1965, and 1966, location 54°44'N, 115°23'W, 4,175 feet a.s.l. altitude.

Swan Dive Forestry Station, at the southeastern extremity of the Swan Hills, is approximately 44 miles east of north from Whitecourt and is nearly 1,900 feet higher. Although the climatic record extends for only three years, the figures confirm the impression formed while doing field work in this area, that on the average summer temperatures are 2 to 5°F lower and monthly precipitation 2 to 3 inches heavier on top of the hills than in the surrounding lowlands.

Geology

No large-scale geological map is available for this area. The geological cross-section on the margin of the geomorphological map that accompanies this report and the following summary are based on work by Allan (1918), Feniak (1944), Home Oils Co. (Anon., 1958), and McCrossan and Glaister (1966).

As indicated on the cross-section, the oldest formation exposed in the map-area is the Edmonton Formation of Late Cretaceous age. This formation is composed of "sandstones, marine and thin-bedded, sometimes weathering into large nodular masses, arenaceous shales with bands of clay-ironstone nodules enclosing fragments of plants, semi-indurated clays, calcareous clay lenses, in the shale and shaly sandstone, and numerous thin seams of coal" (Allan, 1918, p. 11c). It is overlain by the Paleocene Paskapoo Formation. "The beds are varied in character, but indurated and semi-indurated clays, clay shales, arenaceous shales, thin beds of hard and soft grey and ferruginous sandstone and hard, scaly, highly calcareous shales predominate.... Laminae of coal and thin layers of lignitic shale are common; also thin layers of dark shale enclosing carbonized and silicified fragments of wood and bark" (Allan, 1918, p. 10c, 11c).

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TABLE I

Mean Temperatures and Precipitation.

			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Whitecourt Station	Temp. (°F)	Mean	5.0	10.5	21.8	36.9	48.3	54.4	59.7	56.5	48.5	38.0	21.7	8.8	34.2
		Max.	14.8	22.8	33.5	49.2	62.0	66.9	72.9	69.2	60.9	50.0	31.7	18.5	46.1
		Min.	-4.8	-1.8	10.1	24.6	34.6	41.9	46.5	43.8	36.1	26.0	11.7	-0.9	22.3
	Precip. (in.)	Rain	.01	.02	.03	.46	1.76	2.87	3.86	3.33	1.26	.43	.16	0.9	14.28
		Snow	11.1	9.7	7.8	7.4	0.9	0.1	0.0	0.0	0.5	6.4	6.9	9.5	60.3
		Precip.	1.12	.99	.81	1.20	1.85	2.88	3.86	3.33	1.31	1.07	.85	1.04	20.31
Swan Dive Forestry Station	Temp. (°F)	Mean	-	-	-	-	43.5	51.3	57.3	54.6	42.8	42.4	-	-	-
		Max.	-	-	-	-	53.4	61.6	66.5	62.3	50.4	51.1	-	-	-
		Min.	-	-	-	-	33.2	41.5	48.8	47.0	35.1	33.7	-	-	-
	Precip. (in.)	Rain	-	-	-	-	3.01	4.14	5.17	5.94	1.89	.38	-	-	-
		Snow	-	-	-	-	0.0	0.0	0.0	0.0	1.9	1.8	-	-	-
		Precip.	-	-	-	-	3.01	4.14	5.17	5.94	2.08	.56	-	-	-

The structure is simple with no indication of important faulting or folding. The area lies along the northeast limb of the Alberta syncline with dips toward the southwest at "about 40 feet per mile on top of the Beaverhill Lake", an Upper Devonian formation (Anon., 1958, p. 58).

The Paskapoo Formation is unconformably overlain by a poorly consolidated conglomerate composed of water-worn pebbles and cobbles in a matrix of coarse sand. This resistant gravel formation is the reason for the characteristically flat summits of the Swan Hills. Measured thicknesses range from 10 to 40 feet; maximum thicknesses probably exceed 100 feet. The genesis of this fluvial deposit is similar to that of the Cypress Hills Formation (Vonhof, 1965 and pers. comm., 1968). Based on McCrossan and Glaister (1966, p. 191), the Swan Hills gravels have been assigned an Oligocene age on the geomorphological map. More recent work suggests a Miocene or Pliocene age (Stott, 1970, p. 481).

As indicated by the profile on the margin of the map, the "Virginia Hills" south of the Freeman River also are capped by gravel. The highest summit of this low plateau is at least 300 feet below the summit of the Swan Hills profile (Fig. 1). As no fossils have been found in the "Virginia Hills" gravel, dating can only be relative. Their topographically lower position indicates that they are younger than the Swan Hills gravel. They are the highest of a series of gravel-covered benches and terraces leading to the Sangamon(?) gravels at the bottom of the Athabasca Valley (Fig. 1) (St-Onge, 1972a). The gravels capping the "Virginia Hills" and the lower benches rest directly on bedrock and are covered by varying thicknesses of till (Fig. 1). Thus, they range in age from Pliocene to Late Pleistocene (Sangamon). The "Virginia Hills" gravels, being the oldest of the series, are probably Late Tertiary.

Surficial Deposits

Surficial deposits range in age from post-Sangamon(?) to Recent (St-Onge, 1972a).

Within the Swan Hills map-area, till predating the last ice advance has been recognized only as lenses in the Freeman Valley, though this "lower till" is ubiquitous in pre-Wisconsin valleys of the Iosegun-Whitecourt area (Fig. 1 and St-Onge, 1967 and 1968). It is a clayey-silt sand containing less than 5 per cent stones by volume. Its dark grey colour (10YR3/1) and its tendency upon weathering to break into prisms covered by dark brown (5YR3/2) iron oxide makes this a very striking and easily recognizable rock unit.

In several exposures (Fig. 1) the lower till is overlain by lenticular deposits of coarse gravel and sand in which granite boulders up to 3 feet in diameter have been found. In other sections this non-glacial phase is represented by silt beds or by a boulder pavement (St-Onge, 1972a). A small log found in the intertill gravel of a section along the Freeman River, 4.5 miles northwest of Fort Assiniboine yielded a radiocarbon date of 52,200 years (GSC 1019-2).

The overlying "upper till" displays great variety in texture and composition. In low areas it is a massive, grey to dark brown, stony, sandy silt till forming vertical faces along deep valleys. In places it displays a columnar structure. In the hilly regions, however, it becomes a thin, excessively stony veneer resting on glacially deformed bedrock (Fig. 2).

Although large parts of the Whitecourt map-area are covered by thick lacustrine or deltaic deposits (St-Onge, 1972b), these sediments are rare in the Swan Hills map-area. Deltaic sediments generally are limited to the lowlands on either side of the Athabasca Valley.

Geomorphologic Units

Map 1206A illustrates the complexity of landforms in the region, which can be subdivided into five units:

1. Swan Hills Plateau
2. Deeply dissected, gravelly till slopes
3. Moderately dissected, rolling till plain
4. Freeman River valley
5. Dissected "Virginia Hills"

Only a small part of the Swan Hills lies within the map-area. Their top is a nearly flat plateau that is limited by well-defined although relatively gentle slopes (4-8 degrees). It is covered by coarse, mostly quartzite gravel. Muskegs occupy shallow swales on the surface.

The second unit comprises the deeply gullied slopes south and east of the plateau surface and the hilly region south and east of Lois Lake. This is an area of generally thin, stony till. Once the vegetation has been stripped off, gully erosion accentuates the lithologic differences of the various strata of the Paleocene Paskapoo Formation. Thus, these glacially deformed sediments are intricately etched in many road-cuts (Fig. 2).

Most landforms in this area owe their origin to erosion by meltwater channels. As the glacier ice thinned around the plateau summits, marginal meltwater streams flowing east into glacial Lake Iosegun (St-Onge, 1972b) excavated a series of sub-parallel valleys separated by rounded ridges. Elongated, often shallow lakes and bogs have replaced the meltwater streams. Present drainage from the plateau surface is at right angles to the meltwater channels. The result is a grid pattern of small valleys defining more or less rectangular blocks. The town of Swan Hills is located on two of these till-covered small plateaus.

Fluvioglacial sand and gravel deposits are fairly extensive in this second unit, particularly in the northeast corner of the map-area where three esker ridges meander beneath the forest cover; these

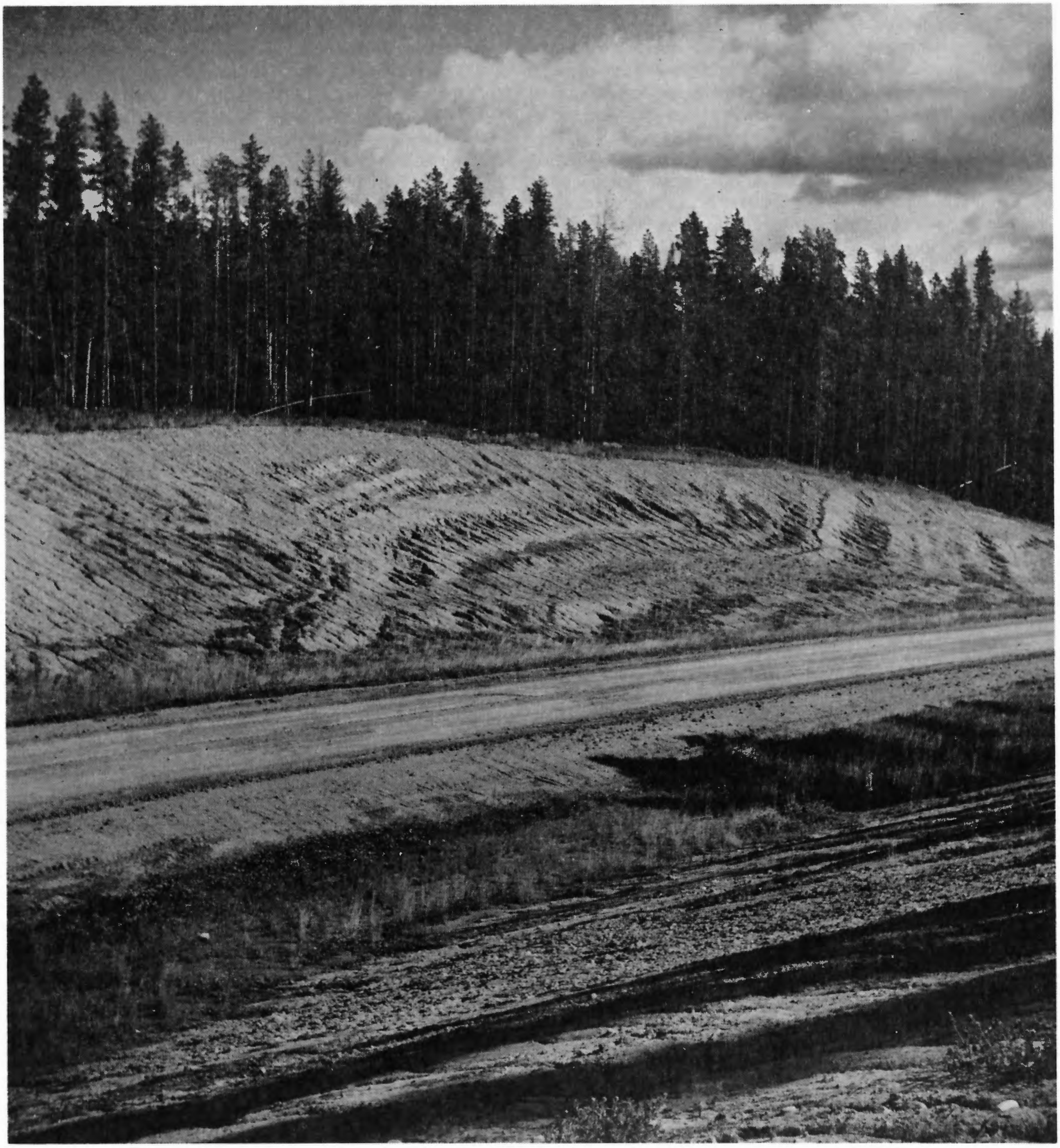

Figure 2. Glacially deformed bedrock on the south slope of the Swan Hills, LSD. 13, sec. 4, tp. 66, rge. 9, W5th meridian. (GSC 124262)

have not been studied on the ground. Also it has been impossible to verify directly the presence of glacial lake sediments in a small basin in the extreme northeast corner of the map-area; their presence is strongly indicated, however, by the pattern of deglaciation and on the airphotos.

The third unit includes approximately one half of the map-area and is between Morse River and Freeman River. It is a rolling till plain, covered by moderately stony till, is dissected by several south-east-flowing streams such as Freeman Creek, Sarah Creek and Morse River. Low, broad morainic ridges, parallel to the drainage net, interrupt the monotony of the gentle relief in this area. 'Doughnuts' or closed ice-disintegration ridges (Gravenor and Kupsch, 1959, p. 52-53) indicate the important role played by stagnating ice in shaping the details of the present landscape. The poor drainage associated with a lower relief area resulted in the accumulation of silt and clay in shallow depressions. These deposits commonly appear as broad, flat fans. Bogs are widespread in low-lying areas.

The 1 to 2 mile- (2 to 3 km-) wide Freeman Valley is a region distinct from all the others (St-Onge, 1968). The present river, with its classic meander belt, occupies a valley that was excavated along the axis of an older one predating the disposition of the two till units identified in the region (St-Onge, 1972a). A terrace 10 to 15 feet (3 to 4 m) above the present river is covered by coarse gravel and sand; the present alluvial plain incised in these deposits also is composed of coarse gravel covered by a layer of sand and silt deposited during floods. Marshes are extensive on the floodplain.

The southwest sector of the map-area is part of the deeply dissected "Virginia Hills". Numerous meltwater channels have denuded this low plateau to a series of isolated blocks. The large meandering channel in the southeast corner of the map-area formed when ice blocked drainage to the east, forcing water to cut a channel southeastward across the east flank of the "Virginia Hills" (St-Onge, 1972b).

Morphochronology

The profiles on the margin of the map and on Figure 1 clearly show that the main elements of the landscape predate glaciation. During Late Tertiary time rivers flowed from the rising Rocky Mountains to the west in large valleys carved in soft Lower Tertiary and Upper Cretaceous sediments. The sharply reduced slope of the plains forced these rivers to deposit the cobbles, pebbles, and coarse sand of their bed load. In places, such as the area now occupied by the Swan Hills, these sediments were spread in large alluvial fans to thicknesses of many feet.

Continued uplift forced rivers to erode valleys at lower levels. The coarse fanglomerate, however, was well beyond the transport capacity of the rejuvenated streams. As a result, the streams carved new, deeper valleys in the soft Upper Cretaceous shales and sandstones alongside the old valleys. Repetition of this process resulted in a landscape consisting of isolated plateaus capped by Miocene/Pliocene gravels as well as sand- and gravel-covered benches and terraces leading down to broad valleys.

Glaciation did not obliterate this general pattern. Major benches and terraces are identified easily on the 1:250,000 topographic map-sheet of Whitecourt, Alberta (83d). Some of the lower, gravel-covered bedrock terraces have been covered by such thick deposits of till and other sediments that they no longer exist as discrete landforms and can be identified only in sections (Fig. 1). Figure 1 shows the main plateaus and benches of the area. A complete sequence of well-defined benches and terraces is not identified because the detailed information necessary to do this is not yet available.

Conclusions

The geomorphological map of the Swan Hills describes and explains discrete features of the landscape, but not to the extent of obliterating major landforms such as the Swan Hills plateau and the several benches below it. Because of the genetic bias of the legend, the map gives a reasonable overall picture of the processes, both past and present, which are responsible for the distribution of landforms.

Tricart (1968) said that only the minor landforms reflect the influence of climate on geomorphology and that major elements of the landscape are of structural, lithologic, or fluvial origin. The geomorphological map of the Swan Hills supports this view. The major landforms are preglacial in age and fluvial in origin; they are related to regional uplift and to fluvial erosion-sedimentation rather than to climatic fluctuations. The major climatic changes of the Quaternary are represented by a generally thin veneer of drift which rarely masks the underlying benches.

Because the glacial deposits are thin and because the underlying soft bedrock is infertile, any land use which implies stripping off the vegetation should be approached with extreme caution as it might initiate gully development and vastly increase sediment load in the streams (St-Onge and Lengellé, 1971).

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